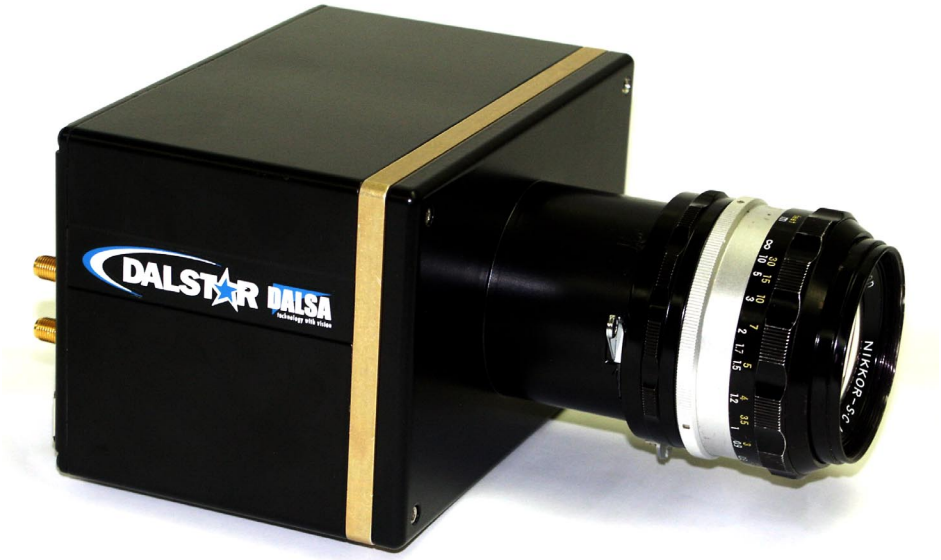
4M30

DS-44-04M30

DS-46-04M30

30 fps 2k x 2k

CCD Camera



User's Manual and Reference

Doc #: 03-32-10030

Rev: 03

DALSA
technology with vision

© 2002 DALSA. All information provided in this manual is believed to be accurate and reliable. No responsibility is assumed by DALSA for its use. DALSA reserves the right to make changes to this information without notice. Reproduction of this manual in whole or in part, by any means, is prohibited without prior permission having been obtained from DALSA.

About DALSA

DALSA is an international high performance semiconductor and electronics company that designs, develops, manufactures, and markets digital imaging products and solutions, in addition to providing wafer foundry services. DALSA's core competencies are in specialized integrated circuit and electronics technology, and highly engineered semiconductor wafer processing. Products include image sensor components; electronic digital cameras; and semiconductor wafer foundry services for use in MEMS, power semiconductors, image sensors and mixed signal CMOS chips.

DALSA is a public company listed on the Toronto Stock Exchange under the symbol "DSA". Based in Waterloo, On. Canada, the company has operations in Bromont, PQ; Colorado Springs, CO; Tucson, AZ; Eindhoven, NL; Munich, Germany and Tokyo, Japan.

All DALSA products are manufactured using the latest state-of-the-art equipment to ensure product reliability.

DALSTAR refers to all DALSA area scan products.

For further information not included in this manual, or for information on DALSA's extensive line of image sensing products, please contact us.

DALSA Sales Offices

Waterloo	Europe	Asia Pacific
605 McMurray Rd Waterloo, ON N2V 2E9 Canada Tel: 519 886 6000 Fax: 519 886 8023 www.dalsa.com sales@dalsa.com	Breslauer Str. 34 D-82194 Gröbenzell (Munich) Germany Tel: +49 - 8142 – 46770 Fax: +49 - 8142 – 467746 www.dalsa.com europe@dalsa.com	Space G1 Building, 4F 2-40-2 Ikebukuro Toshima-ku, Tokyo 171-0014 Japan +81 3 5960 6353 (phone) +81 3 5960 6354 (fax) www.dalsa.com asia@dalsa.com

DALSA Worldwide Operations

Waterloo	Colorado Springs	Tucson	Europe	Asia Pacific
605 McMurray Rd Waterloo, ON N2V 2E9 Canada Tel: 519 886 6000 Fax: 519 886 8023 www.dalsa.com sales@dalsa.com	5055 Corporate Plaza Drive Colorado Springs, CO 80919 USA Tel: 719 599 7700 Fax: 719 599 7775 www.dalsa.com sales@dalsa.com	3450 S. Broadmont Dr. Suite #128 Tucson, AZ 85713-5245 USA Tel: 520 791 7700 Fax: 520 791 7766 http://lifesciences.dalsa.com sales@dalsa.com	Breslauer Str. 34 D-82194 Gröbenzell (Munich) Germany Tel: +49 - 8142 – 46770 Fax: +49 - 8142 – 467746 www.dalsa.com europe@dalsa.com	Space G1 Building, 4F 2-40-2 Ikebukuro Toshima-ku, Tokyo 171-0014 Japan +81 3 5960 6353 (phone) +81 3 5960 6354 (fax) www.dalsa.com asia@dalsa.com

Contents

Introduction to the 4M30 Camera 5

1.1 Camera Highlights 5
1.2 Image Sensor 6
1.3 Camera Performance Specifications 7

Camera Hardware Interface 9

2.1 Installation Overview 9
2.2 Input/Output 9
2.3 LED Status Indicators 10
2.4 Power Input 11
2.5 Data Output 12
2.6 Serial Communication 14
2.7 TTL Trigger Input and Output 16
2.8 Integration Time 18
2.9 Timing 18

Camera Operation 20

3.1 How to Control the Camera 20
3.2 ADC Commands 22
3.3 Clock Commands 22
3.4 Control Register Reference 23
3.5 Reading the Camera Type 23
3.6 Reading the Firmware Revision 24
3.7 Resetting the ADC boards ("soft" reset) 24
3.8 Resetting the Camera ("hard" reset) 24
3.9 Adjusting Gain 25
3.10 Adjusting User Offset 26
3.11 Automatic Offset Control (AOC) 27
3.12 No Clean Mode 27
3.13 Triggering, Integration, and Frame Rate Overview 28
3.14 Controlling Integration (Shutter Time) 28
3.15 Controlling Frame Rate 31

Optical and Mechanical Considerations 34

4.1 Mechanical Interface 34

4.2 Mechanical Tolerances 35
4.3 Mounting the Camera 35

Cleaning and Maintenance 36

5.1 Cleaning 36
5.2 Maintenance 38

Troubleshooting 39

Warranty 40

7.1 Limited One-Year Warranty 40

Appendix A 41

LVDS (EIA-644) Reference 41

Index 44

1

Introduction to the 4M30 Camera

1.1 Camera Highlights

Features

- 2048 x 2048 resolution, full-frame CCD architecture
- 30 fps four output, 4x40 MHz data rate
- True 12-bit digitization
- High sensitivity with low dark current
- Progressive scan readout
- Asynchronous image capture, externally triggerable to within 175 ns.
- Programmable operation via RS232, including gain (1x – 10x), offset (±full scale), and triggering
- 100% fill factor
- DS-44-04M30 is the standard 4M30 camera
- DS-46-04M30 has a sensor with taped on coverglass

Description

The 4M30 digital camera provides high-sensitivity 12-bit images with 2k x 2k spatial resolution at up to 30 frames per second (fps). The 4M30 is a full frame CCD camera using a progressive scan CCD to simultaneously achieve outstanding resolution and gray scale characteristics. A square pixel format and high fill factor provide superior, quantifiable image quality even at low light levels.

Applications

The 4M30 is an outstanding performer in fast, very high resolution applications. True 12 bit performance provides up to 4096 distinct gray levels—perfect for applications with

large interscene light variations. The low-noise, digitized video signal also makes the camera an excellent choice where low contrast images must be captured in challenging applications.

1.2 Image Sensor

This section is not applicable to part number DS-46-04M30

The 4M30 uses DALSA's IA-DA-2048 high-performance full-frame CCD.

Figure 1. IA-DA-2048 Image Sensor Block Diagram

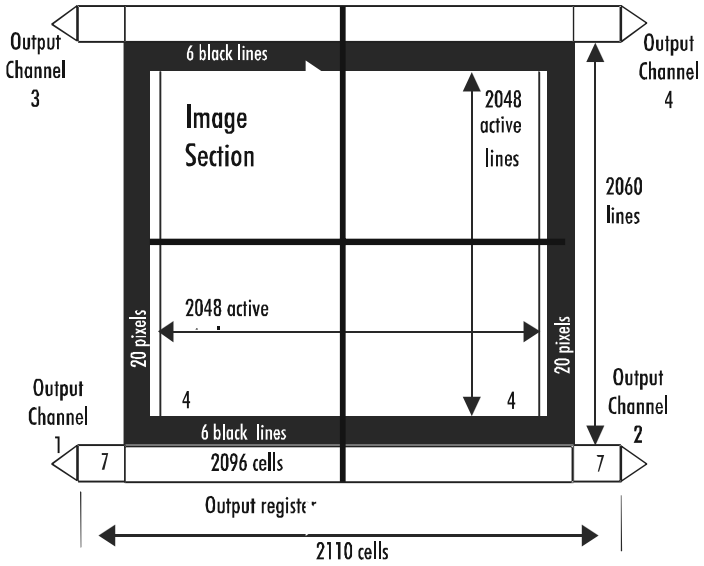


Table 1. IA-DA-2048 Sensor Structure

Sensor characteristics	
Optical size	24.576mm (H) x 24.576 mm (V)
Chip size	26.860 mm (H) x 26.508 mm (V)
Pixel size	12µm x 12µm
Active pixels	4 * [1024 (H) x 1024 (V)]
Total number of pixels	2096 (H) x 2060 (V)
Optical black pixels	Left: 20 Right: 20
Timing pixels	Left: 4 Right: 4
Dummy register cells	Left: 7 Right: 7
Optical black lines	Bottom: 6 Top: 6

Table 2. IA-DA-2048 Sensor Cosmetic Specifications

Specification	Grade 02
a) Number of first and last columns excluded	16
b) Number of first and last rows excluded	16
c) Maximum quantity of single pixel blemishes	unspecified
d) Maximum quantity of cluster blemishes	75

Specification	Grade 02
e) Maximum size of clusters (adjacent pixels)	30
f) Blemish pixel deviation from VFLL* under illumination	>10% <45%
g) Blemish pixel deviation from average dark level, measured at dark	>20mV

Notes:

*VFLL is defined as the output signal under broadband quartz tungsten halogen light with an irradiance of $4.08\mu W/cm^2$.

1. All sensors are tested in four output mode – 1x gain.
2. Blemish variations are measured over an entire frame of data and counted within the frame boundaries defined by a) and b).
3. Blemishes are defined as a pixel or group of pixels with an output as defined in f) or g).
4. Clusters are defined as a pixel or group of pixel blemishes, and are allowed, provided they are smaller or equal to the sizes specified in e).
5. Illuminated blemish analysis done at 70% of VFLL ($2.86\mu W/cm^2$).
6. Column and row defects not permitted.
7. Better than grade 02 sensors may be available. Please contact DALSA sales if interested.

1.3 Camera Performance Specifications

Table 3: 4M30 Camera Performance Specifications

Physical Characteristics	Units				Notes
Resolution	H x V pixels	2048x2048			
Pixel Size	µm	12x12			
Pixel Fill Factor	%	100			
Size	mm	146x92x143			
Mass	kg	1.3			
Power Dissipation	W	< 24			
Lens Mount		F mount			
Aperture	mm	24.6 x 24.6			
Operating Ranges	**Units**	**Min.**	**Max.**		
Frame Rate	Fps		30		
Data Rate	MHz	4*40	4*40		
Data Format	LVDS		4*12 bit		
Responsivity	$DN/(nJ/cm^2)$	24@530nm			4
Operating Temp	°C	10	40		
+15 Input Voltage	V	+14.925	+15.075		
+5 Input Voltage	V	+4.975	+5.025		

Physical Characteristics	Units				Notes
-5 Input Voltage	V	- 4.975	- 5.025		
Nominal Gain Range		1x	10x		
Calibration Conditions	**Units**	**Setting**	**Min.**	**Max.**	
Data Rate	MHz	4x40	4x40	4x40	
+15 Input Voltage	V	+15	+14.925	+15.075	
+5 Input Voltage	V	+5	+4.975	+5.025	
-5 Input Voltage	V	- 5	- 4.975	- 5.025	
Ambient Temperature	°C	25			
Gain	X	1x			
Electro-Optical Specifications	**Units**	**Min.**	**Typical**	**Max.**	
Dynamic Range	dB	64.0	67.0		1
Pixel Response Non-Uniformity	%rms		2.0	3.0	2, 4
System Noise	DN(rms)		2.1	2.4	

Notes:

1. Dynamic Range = 20 * log10[(Counts @ Full Well)/Read Noise]
2. PRNU = [[[STDEV(100 frames @ saturation)/(MEAN @ saturation)]-Dark Offset(in darkness)]*100
3. System Noise = Read Noise (e^-)/Gain (e^-/DN) dark measurement
4. Specification not applicable to the DS-45-04M30 due to Lumogen coated sensor

2

Camera Hardware Interface

2.1 Installation Overview

This installation overview assumes you have not installed any system components yet.

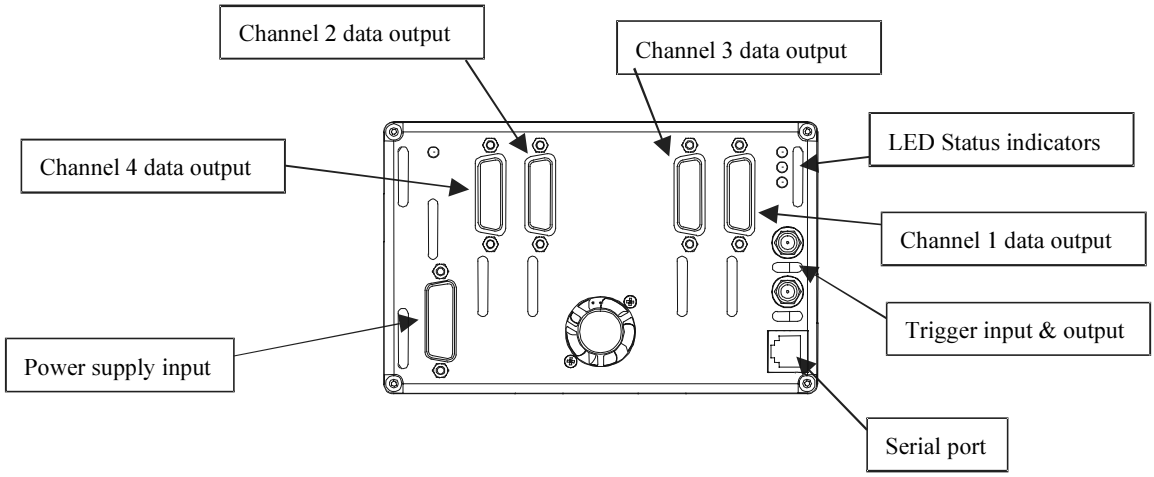
In order to set up your camera, you should take these initial steps:

1. Power down all equipment.
2. Following the manufacturer's instructions, install the frame grabber (if applicable). **Be sure to observe all static precautions.**
3. Install any necessary imaging software.
4. Before connecting power to the camera, test all power supplies. **Ensure that all the correct voltages are present at the camera end of the power cable** (Refer to the Camera Performance Specifications on page 7). Power supplies must meet the requirements defined in section 2.4 Power Input.
5. Inspect all cables and connectors prior to installation. Do not use damaged cables or connectors or the camera may be damaged.
6. Connect data, serial interface, and power cables.
7. After connecting cables, apply power to the camera. The POST (power on self test) LED on the back of the camera should glow green after one second to indicate that the camera is operating and ready to receive commands.

2.2 Input/Output

The camera provides 12-bit LVDS data and synchronization signals through the data output connector. Camera functions such as integration time, camera gain and offset are all controllable by the user via the RS232 serial port. The camera is capable of free running operation or may be triggered externally via the input TRIGGER IN. TRIGGER OUT allows the synchronization of shutters or illumination sources in free running or externally triggered modes.

Figure 2: Camera Inputs/Outputs



2.3 LED Status Indicators

There are four LED's visible on the rear cover of the camera that indicate the camera's status.

Table 4: LED Functions

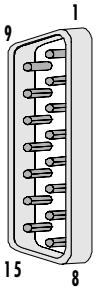
LED Label	Color	LED "ON"	LED "OFF"
ON	Green	Camera is receiving power	No camera power
POST	Green	Camera Power On Self Test successful	Camera failed Power On Self Test
BIN	Green	Not Operational	Not Operational
MODE	Green	Camera is in an external trigger mode (uses external signal to trigger image capture)	Camera is triggering image capture internally

2.4 Power Input

WARNING: It is extremely important that you apply the appropriate voltages to your camera. Incorrect voltages will damage the camera.

Table 5: Power Connector Pinout

Pin	Symbol
1	+5V
2	+5V
3	- 5V
4	+15V
5	NC
6	NC
7	GND
8	GND
9	+5V
10	- 5V
11	+15V
12	+15V
13	NC
14	GND
15	GND



DB15M
(AMP Part # 747236-4
or equivalent)

The camera has the following input power requirements:

V (DC)	±%	Max Ripple mV	A
+15	.0.5	< 50	0.5
+5	0.5	< 50	3.7
-5	0.5	< 50	0.8

Note: Performance specifications are not guaranteed if your power supply does not meet these requirements.

DALSA offers a linear power supply (with cables) that meets the 4M30's requirements (Universal Power Supply, part number 24-00001-02, contact DALSA for more information), but it should not be considered the only choice. Many high quality supplies are available from other vendors. DALSA assumes no responsibility for the use of these supplies.

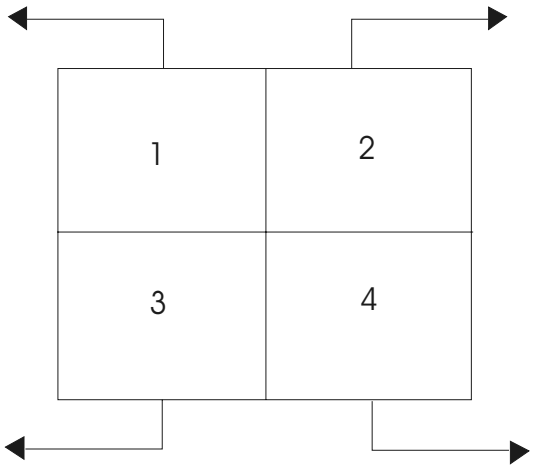
When setting up the camera's power supplies, follow these guidelines:

- Do not connect or disconnect cable while power is on.
- Do not use the shield on a multi-conductor cable for ground.
- Keep leads as short as possible to reduce voltage drop.
- Use high-quality **linear** supplies to minimize noise.

2.5 Data Output

Figure 3 illustrates the data channel outputs when viewed from the front of the CCD. Arrows indicate channel read out direction.

Figure 3: Channel read out direction

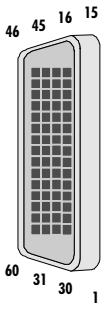


The camera back panel output connectors DATA1, DATA 2, DATA 3, and DATA 4 utilize differential LVDS signals with pin assignments described in Table 6.

Connector and Pinout

Table 6: DATA Connector Pinout

Pin	Symbol	Pin	Symbol	Pin	Symbol	Pin	Symbol
1	D*0+	16	Reserved	31	NC	46	GND
2	D*0-	17	D*7+	32	NC	47	NC
3	D*1+	18	D*7-	33	NC	48	NC
4	D*1-	19	D*8+	34	NC	49	NC
5	D*2+	20	D*8-	35	NC	50	NC
6	D*2-	21	D*9+	36	NC	51	NC
7	D*3+	22	D*9-	37	NC	52	NC
8	D*3-	23	D*10+	38	NC	53	Reserved
9	D*4+	24	D*10-	39	NC	54	Reserved
10	D*4-	25	D*11+	40	NC	55	VSYNC-
11	D*5+	26	D*11-	41	NC	56	VSYNC+
12	D*5-	27	NC	42	NC	57	HSYNC-
13	D*6+	28	NC	43	NC	58	HSYNC+
14	D*6-	29	NC	44	NC	59	PIXCLK-
15	Reserved	30	NC	45	GND	60	PIXCLK+



(Molex Part # 70928-2000 or equivalent)

NC = No Connect. These pins are unused.

WARNING. Care must be taken when connecting data cables to the camera to insure proper connection and to prevent damage to the connector.

Data Signals

Table 7: Data Signal Definition

Signal	Description
D*0+, D*0-	Data bit 0 true and complement—Output. (Least significant bit.)
D*1+, D*1-	Data bit 1 true and complement—Output.
D*2+, D*2-	Data bit 2 true and complement—Output.
D*3-D*10+,- etc.	Etc.
D*11+, D*11-	Data bit 11 true and complement—Output. (Most significant bit.)

IMPORTANT:
This camera uses the ***falling*** edge of the pixel clock to register data.

Digitized video data is output from the camera as LVDS differential signals using 4 Molex 60-pin connectors on the rear panel (labeled "DATA 1 through DATA 4"). The data is synchronous and is accompanied by a pixel clock and clocking signals.

Data Clocking Signals

Table 8: Clock Signal Descriptions

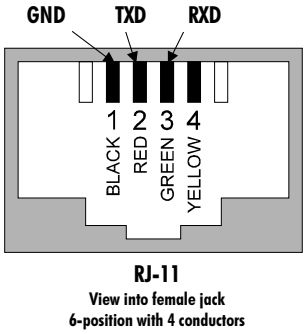
Signal	Description
PIXCLK+, PIXCLK-	Pixel clock true and complement. 40MHz—Output. Data is valid on the falling edge.
HSYNC+, HSYNC-	Horizontal sync, true and complement—Output. HSYNC high indicates the camera is outputting a valid line of data.
VSYNC+, VSYNC-	Vertical sync, true and complement—Output. VSYNC high indicates the camera is outputting a valid frame of data.

2.6 Serial Communication

Connector and Pinout

The serial interface provides control of frame rate, integration time (shuttering), video gain and offset, external trigger and external integration. For information on how to control these functions, see Camera Operation, beginning on page 20. The remote interface consists of a two-wire (plus ground) full duplex RS-232 compatible serial link, used for camera configuration, and two back panel SMA coax connectors used for external trigger input and output.

The camera uses an RJ-11 telephone-style connector for serial communications, with four conductors installed in a six-position connector. Note that both four- and six- conductor plugs may be used interchangeably with the RJ-11 jack.



IMPORTANT: Both the PC / AT and the camera are configured as "DTE" (Data Terminal Equipment) devices requiring the TXD and RXD lines to be swapped when interconnecting the two (note that pin 4, normally the yellow wire, is not used on the RJ-11.) That is, the TXD pin represents DATA OUT and the RXD pin represents DATA IN on both devices, so that one device's TXD line must connect to the other device's RXD line and vice-versa.

Figure 4: 25 Pin Serial Port Connector to Camera RJ-11 Connector

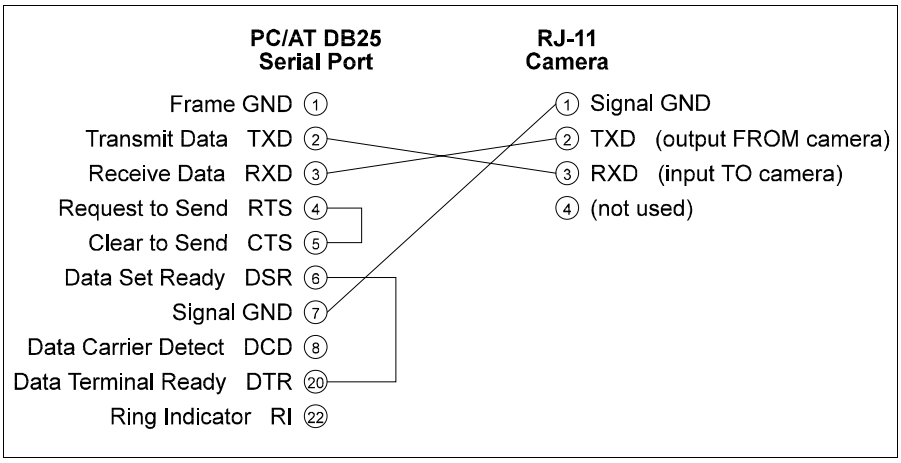
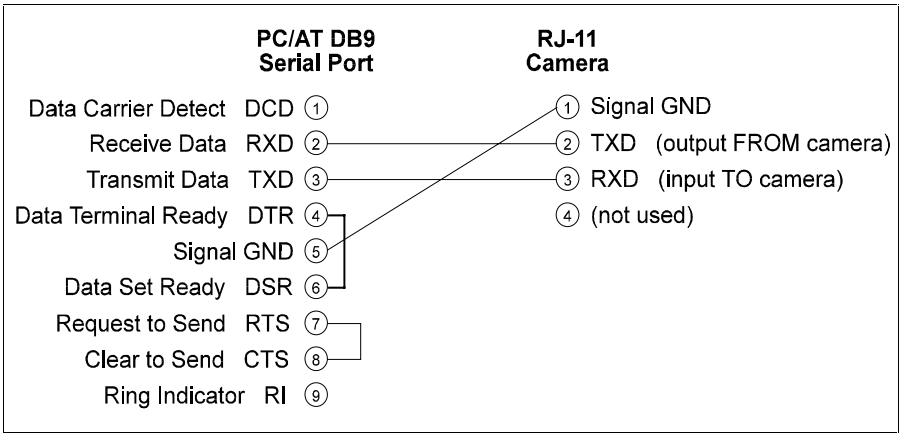


Figure 5: 9 Pin Serial Port Connector to Camera RJ-11 Connector



Serial Communication Settings

Table 9: Serial Port Configuration

Serial Port Configuration	
Baud	9600, fixed
Start bits	1
Data bits	8
Stop bits	1
Parity	None

The serial interface operates at RS-232 levels with fixed parameters of 9600 baud, 1 start bit, 8 data bits, 1 stop bit, and no parity. The interface uses only three wires, for received data, transmitted data, and ground. In general writing data must start with a write command byte and be followed by a data byte. Reading a camera register requires only a single read command byte.

WARNING: Due to initialization sequencing after power-up, no commands should be sent to the camera for a minimum of 1 second after power up.

The remote interface connector, on the cameras rear panel, is specified as a low-profile RJ-11 modular connector. The connector is a 6-position model, but only the center four positions are populated with contacts. It will mate with either the 4-position or 6-position cable plugs. This type of connector typically requires special assembly tools; complete cable assemblies are available from suppliers such as Digi-Key:

Serial Cable Source

Digi-Key
701 Brooks Ave. South
Thief River Falls, MN 56701
1-800-344-4539
cable part number:
H2643-14-ND (14 feet)

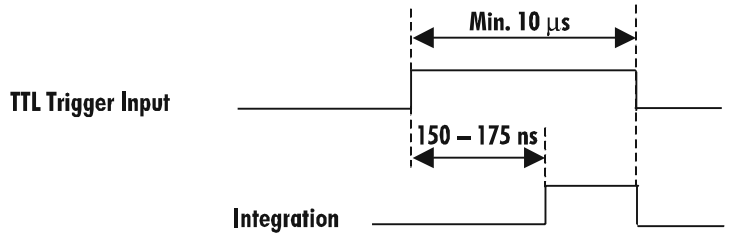
DALSA provides serial cables in 3 lengths: 10', 20' and 50'. Part number CL-31-00004-xx (where xx refers to the cable length in feet).

2.7 TTL Trigger Input and Output

Connector

The camera uses an SMA connector (labeled TRIGGER IN) to allow the user to provide a standard TTL signal to control camera integration and readout. The input is high impedance (>10.5K), allowing the user to terminate at the SMA input as needed. The camera has another SMA connector (TRIGGER OUT) that provides a standard TTL output which is high whenever the camera is integrating.

Figure 6: Trigger Timing Description



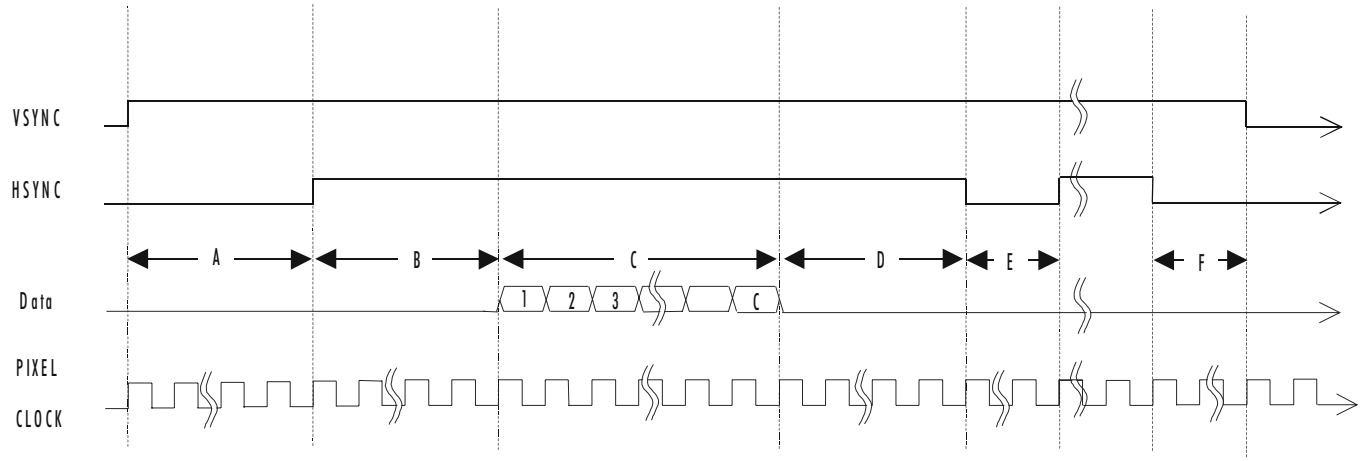
2.8 Integration Time

The minimum integration time (or shutter time) is 10 µs. As with any full frame imager, the camera will continue to integrate during read out unless externally shuttered or strobed.

2.9 Timing

The 4M30 pixel clock runs at 40 MHz, so each pixel clock cycle will be 1/40,000,000 or 25ns. The following diagram and tables describe the correct timing requirements for the 4M30 camera.

Figure 7: 4M30 Timing



"A" represents the number of falling clock edges from the rising edge of VSYNC to the rising edge of HSYNC.

"B" represents the number of falling clock edges prior to the first word. (Pre-Scan pixels)

"C" represents the number of words per line.

"D" represents the number of falling clock edges between the last word and the falling edge of HSYNC. (Post-Scan pixels)

"E" represents the number of falling clock edges between a falling HSYNC and a rising HSYNC.

"F" represents the number of falling clock edges from the falling edge of HSYNC to the falling edge of VSYNC

IMPORTANT:
This camera uses the ***falling*** edge of the pixel clock to register data.

Table 10: HSYNC Pixel Timing

Horizontal Binning Mode	A	B	C	D	E	F
1x	213	18	1024	18	196	2

Table 11: VSYNC Pixel Timing (HSYNC falling edges/VSYNC falling edge)

Vertical Binning Mode	Pre-Scan Lines/Frame	Active Lines/Frame	Post Scan Lines/Frame
1x	6	1024	0

3

Camera Operation

3.1 How to Control the Camera

The 4M30's RS-232-compatible serial interface allows you to control its configuration and operation, including:

- Triggering Mode
- Frame Rate
- Integration Time
- Gain
- Offset
- Reset

Command Protocol Overview

The camera accepts 8-bit command / value pairs via its RJ-11 serial port using RS-232 compatible signals.

Serial Port Configuration	
Baud	9600, fixed
Start bits	1
Data bits	8
Stop bits	1
Parity	None

Camera commands are divided into two basic sets:

- "clock" commands which apply to the electronics that drive the image sensor. These include clock generation, frame rate, integration time, and binning. Clock commands effect the entire camera, and are not channel specific. A single command will impact all channels.
- "ADC" commands which apply to the electronics that process and digitize the video. These include gain and offset. ADC commands are channel specific. Four separate commands must be issued to change all four channels.

- Each set of commands includes read and write variants. With the exception of reset commands, all 8-bit write commands must be followed by an 8-bit data byte. The commands are interpreted as follows:

Table 12: ADC Bit Definitions

Bit	Function
0:3	Command Register Address (Reference Table 12)
4:5	ADC Board Address 00 = ADC Channel 1 01 = ADC Channel 2 10 = ADC Channel 3 11 = ADC Channel 4
6	Command Type 0 = Write 1 = Read
7	Board Type 0 = ADC Board 1 = Clock Board

- Any commands not listed in this manual should be considered invalid to the 4M30 user.
- A number of functions and modes depend on the ADC / Control Register settings. These settings are detailed in the following sections.
- The "Write Control Register" command is used to write data that controls specific camera triggering and test functions. This command must be followed by a data byte with bits defined in Table 15.
- The "Read" command allows interrogation of the camera to determine current configuration.

WARNING: Any commands not listed should be considered invalid. Writing to invalid addresses may overwrite camera calibration information, requiring the camera to be returned for recalibration.

WARNING: Due to initialization sequencing after power-up, no commands should be sent to the camera for a minimum of 1 second after power up.

3.2 ADC Commands

Table 13: Summary of ADC Commands

Control	Write Command		Read Command		Channel	Function
	Hex	Binary	Hex	Binary		
ADC Board Soft Reset	*0h	00** 0000	NA	NA	1,2,3,4	Resets ADC board only
User Offset	*2h	00** 0010	*2h	01** 0010	1,2,3,4	LS byte of 16 bit user controllable offset
	*3h	00** 0011	*3h	01** 0011	1,2,3,4	MS byte of 16 bit user controllable offset
User Gain	*5h	00** 0101	*5h	01** 0101	1,2,3,4	LS byte of 16 bit gain
	*6h	00** 0110	*6h	01** 0110	1,2,3,4	MS byte of 16 bit gain
AOC	*8h	00** 1000	NA	NA	1,2,3,4	AOC Adjustment

* Reference Table 11 for appropriate entry

3.3 Clock Commands

Table 14: Summary of Clock Commands

Control	Write Command		Read Command		Channel	Function
	Hex	Binary	Hex	Binary		
Reset Camera	80h	1000 0000	NA	NA	1,2,3,4	Resets all registers to default values
Read Camera Type	NA	NA	C3h	1100 0011	1,2,3,4	Returns Camera ID register (4Bh)
Read Firmware Rev	NA	NA	C5h	1100 0101	1,2,3,4	Returns Firmware revision register
Control Register	82h	1000 0010	C2h	1100 0010	1,2,3,4	Control Register settings
Integration Time	8Ah	1000 1010	NA	NA	NA	Write byte 0 of 18 bit integration time
	8Bh	1000 1011	NA	NA	NA	Write byte 1 of 18 bit integration time
	8Ch	1000 1100	NA	NA	NA	Write byte 2 of 18 bit integration time
Frame Rate	8Dh	1000 1101	NA	NA	NA	Write byte 0 of 18 bit frame rate time
	8Eh	1000 1110	NA	NA	NA	Write byte 1 of 18 bit frame rate time
	8Fh	1000 1111	NA	NA	NA	Write byte 2 of 18 bit frame rate time

3.4 Control Register Reference

Table 15: Control Register Bit Definitions

Register	Write Command	Read Command	Bit	Function	Default
Control Register	82h	C2h	7	Integration Mode 0=Internal 1=External	1
			6:4	Always 0	000
			3	Trigger Mode 0=Internal 1=External	0
			2	No Clean Mode (External Integration Only) 0 = Camera flushes charge between frames 1 = Charge is not flushed	1
			1	Always 0	0
			0	Serial Trigger Bit	0

3.5 Reading the Camera Type

This read command returns an 8-bit value unique to the type of camera interrogated. A 4M30 will return a value of 4Bh when this command is issued. This is useful for applications that need to function with multiple DALSTAR camera types.

Example: Read the camera type

	Command	Value Returned (4M30)
Binary	1100 0011	0100 1011
Hex	C3h	4Bh

3.6 Reading the Firmware Revision

This command returns a byte in which the lower nibble is the revision number for the clock board firmware and the upper nibble is undefined. The ability to read this value may assist in customer support issues.

Example: Read the firmware version

	Command
Binary	1100 0101
Hex	C5h

3.7 Resetting the ADC boards ("soft" reset)

When this command is issued, the microprocessor on the ADC board will restart execution as if the micro was just powered up. This causes the dark reference control loop to restart at its initial values before settling in to the calibrated dark reference level of approximately 50 counts. This is useful because under some conditions, issuing a soft reset to the ADC board's microprocessor after camera operating conditions have changed will improve the rate at which the offset control loop pulls into the calibrated level.

This is one of only two "write" commands that are not followed by a data byte.

Example

Use this command to reset ADC Channel 3:

	Command	Value
Binary	0010 0000	-
Hex	20h	-

3.8 Resetting the Camera ("hard" reset)

This is the only other "write" command that is not followed by a data byte. This command resets all clock board registers to their default values (the values used at power-up).

Example

Use this command to reset the camera:

	Command	Value
Binary	1000 0000	-
Hex	80h	-

Table 16: Default values in effect after reset

Feature	4M30 Default
Frame Rate (fps)	External Cntrl
Integration Time (ms)	External Cntrl
Video Gain	1x
Pixel Offset	50 DN
Trigger Mode	External
Integration Control	External
Data Rate (MHz)	4x40

3.9 Adjusting Gain

Video gain is adjustable from 1.0 to 10.0 by writing a 16 bit value as an MS and LS byte (only the 14 most significant bits of this value are actually used). The amplifier used for gain control has a ranger of 40 dB, which equates to an adjustment increment of 0.00244 dB ($40dB/2^{14}$). The camera gain value is calculated according to the following equation:

$$Value \cong 27306 * \log_{10}(Gain)$$

$$Where\ 1.0 \leq Gain \leq 10.0$$

Example: Set Channel 1 to 2.5x Gain

Use these command / value pairs set the camera to 2.5x gain (you must write both MSB and LSB values to all four ADC channels).

$$Value \cong 27306 \times \log_{10}(2.5)$$

$$Value = 10866$$

$$= 2A72h$$

	Write MSB		Write LSB	
	Command	Value	Command	Value
Binary	0000 0110	0010 1010	0000 0101	0111 0010
Hex	06h	2Ah	05h	72h

Reading Channel 3 Gain from the Camera

To read the gain setting from the camera, use these commands:

	Read MSB	Read LSB
Binary	0110 0110	0110 0101
Hex	66h	65h

3.10 Adjusting User Offset

User offset is adjustable from minus full scale to plus full scale (±4095) by a 16 bit value as an MS and LS byte (only the 14 most significant bits of this value are actually used). There are 4 ADC video boards in the 4M30 and each can be controlled independently. Normally, the same value will be written to all four channels. The value is calculated according to the following equation:

$$\text{Value} \cong 218 \times \text{Offset/Gain}$$

$$\text{Where Offset is in counts and } -4095 \leq \text{Offset} \leq 4095$$
$$\text{And } 1 \leq \text{Gain} \leq 10 \text{ and is defined as above.}$$

This means that the offset is dependent on the gain and can be adjusted with a resolution of 0.5 x Gain (in DN counts).

Example: Set Channel 2 to 20 DN Offset @ 2.5x Gain

Use these command / value pairs set the camera to an offset of 20 DN at a gain of 2.5 (you must write both MSB and LSB values).

$$\text{Value} \cong 218 \times 20/2.5$$

$$\text{Value} = 1744$$

$$= 06D0h$$

	Write MSB		Write LSB	
	Command	Value	Command	Value
Binary	0001 0011	0000 0110	0001 0010	1101 0000
Hex	13h	06h	12h	D0h

The read user offset commands allow the user to read back this information from the camera.

Reading Channel 4 Offset from the Camera

To read Channel 4 offset setting from the camera, use these commands:

	Read MSB	Read LSB
Binary	0111 0011	0111 0010
Hex	73h	72h

3.11 Automatic Offset Control (AOC)

The AOC defines the digitized value of black for the camera. An ideal camera (no dark current, no shot noise, etc.) in total darkness produces an image with all pixels equal to the AOC set point value. This command allows you to control the AOC set point of the ADC video board. The four ADC video boards in the 4M30 can each be controlled independently. Normally all channels are controlled with the same set point value. The default value is 50 DNs, or counts.

Example: Set the Channel 2 AOC Set Point to 32 DNs

Value = 32

= 20h

	Command	Value
Binary	0001 1000	0010 0000
Hex	18h	20

3.12 No Clean Mode

There is no way to prevent the CCD imager from integrating (accumulating charge due to light falling on the imager). Under some conditions this will cause the image to show smearing in the vertical direction, and increase Dark Current. In order to reduce this effect, the 4M30 camera runs horizontal and vertical clocks during idle time to flush the charge. Under some conditions, this feature may be undesirable. For example, when wanting to synchronize camera integration to an external event in the External Integration Mode. Under these conditions, the user can enable the No Clean Mode by setting bit [2] in the Control Register = 1. No Clean Mode can only be enabled when in Programmed Integration Mode (bit [7] of the Control Register =1)

Example: Enable No Clean Mode

	Command	Value
Binary	1000 0010	1*** *1**
Hex	82h	**h

Note: The register containing the No Clean bit also controls other configuration data (*). All bits must be set appropriately.

3.13 Triggering, Integration, and Frame Rate Overview

Image capture triggering, integration, and frame rate are closely related.

- Integration time can be less than 1/frame rate, but it can never be greater than 1/frame rate.
- You can program fixed integration (or use default) and let the camera "free run."
- You can program fixed integration time and supply a (asynchronous) trigger signal to control frame rate by supplying a TTL pulse on the SMA connector. This is referred to as "Programmed Integration/External Trigger Mode."
- You can also have the camera integrate as long as an asynchronous TTL pulse is held high. This pulse will therefore control both integration time and frame rate. This is also known as "External Integrate Mode."

For a given frame rate, the maximum integration time is limited to the frame period less an overhead factor required for proper operation of the CCD. Maximum integration time is defined by this equation:

$$\text{Max Integration Time} = (1/\text{Frame Rate}) - 32.35\ \text{ms}$$

This equation is valid for all modes, free running, external trigger and external integrate modes.

WARNING: Do not set integration time higher than the limits of the equation above. Unpredictable operation may result

3.14 Controlling Integration (Shutter Time)

The 4M30 allows you to control integration (also known as exposure time or shutter time) in these ways.

- **Programmed Integration/Free Running**: (default) The camera free runs with the internally programmed integration time and frame rate
- **Programmed Integration/SMA Trigger:** The camera will integrate for the internally programmed time when triggered by a high going TTL pulse on the SMA connector.
- **Programmed Integration/Serial trigger:** The camera will integrate for the internally programmed time when triggered by a high going Serial Trigger signal.
- **External Integration/SMA Trigger:** The camera will integrate as long as the TTL pulse on the TRIGGER IN SMA connector is high. The integration time is effectively the input pulse width. In this mode, TRIGGER IN also controls the frame rate.

- **External Integration/Serial Trigger:** The camera will integrate as long as the Serial Trigger signal is held high. The integration time is effectively the input pulse width. In this mode, the serial signal also controls the frame rate. Due to variation in the host operating system, this mode is generally used only for camera setup and functional testing.

The register settings required for each mode are defined in Table 17: Integration / Trigger Modes.

Table 17: Integration/Trigger Modes

Mode	Control Register Bit [7] INTEGRATE	Control Register Bit [3] EXT Trigger
Programmed Integration / Free Running	0	0
Programmed Integration / SMA Trigger	0	1
Programmed Integration / Serial Trigger	0	1
External Integration / SMA Trigger	1	1
External Integration / Serial Trigger	1	1

Whenever the Integrate Mode or External Trigger Mode bits are set the **MODE** LED on the right side of the rear cover will light to indicate that an externally synchronized mode is active.

Free Running (Programmed Integration):

The camera speed is controlled by writing a 3-byte integration time value (in µs) to the three Integration Time registers. These three bytes are then combined to form a 24 bit integration time. The number represents the integer number of microseconds the camera will collect light. The number programmed in the three registers should not be below 10 µS (0000Ah). The camera will run at maximum speed for the programmed integration time.

Example: Set integration time to 10ms

With an internal integration time of 10 ms, the camera will operate at 23.6 fps.

$$1/\text{Frame Rate} = 10\ \text{ms} + 32.35\ \text{ms}$$

$$= 42.35\ \text{ms}$$

1. Using the command 82h, set bit [7] of the data byte to 0 (Integration Mode = Internal) and bit [3] of the data byte to 0 (Trigger Mode = Internal).

   NOTE: All bits within the register are written at one time. Ensure the correct value for all bits are used when changing camera modes.

2. Use commands 8Ah, 8Bh, 8Ch to set the 24-bit integration time value.

$$\text{Value} = 10\ \text{ms}$$

$$= 10000\ \mu\text{s}$$

$$= 002710\text{h}$$

	Write Integration LS Byte		Write Integration Center Byte		Write Integration MS Byte	
	Command	Value	Command	Value	Command	Value
Binary	1000 1010	0001 0000	1000 1011	0010 0111	1000 1100	0000 0000
Hex	8Ah	10h	8Bh	27h	8Ch	00h

Programmed Integration/SMA Trigger

For external SMA controlled triggering with a programmed integration time, a TTL rising edge on TRIGGER IN connector triggers the camera to acquire one frame of data. Integration begins within 175 ns after the rising edge and stops when the programmed integration time has completed. After that single frame acquisition, the camera outputs the just acquired frame and "re-arms", thus waiting for a new External Trigger signal to trigger a new frame acquisition. The camera is "armed" when the read out of the acquired frame is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or frame read out*.

When the camera is in External Trigger Mode, the MODE LED will be illuminated on the camera back to indicate the camera is expecting a signal on the TRIGGER IN connector or Serial Trigger bit [0] of the Control Register.

Because this signal is internally OR'ed with the Serial Trigger bit [0] of the Control Register, care must be taken to ensure the bit [0] of the Control Register is not changed from logic 0 to 1 while triggering with the TRIGGER IN connector.

Programmed Integration/Serial Trigger

For external serial controlled triggering with a programmed integration time, a TTL rising edge on bit [0] of the Control Register triggers the camera to acquire one frame of data. Integration begins within 175 ns after the rising edge and stops when the programmed integration time has completed. After that single frame acquisition, the camera outputs the just acquired frame and "re-arms", thus waiting for a new External Trigger signal to trigger a new frame acquisition. The camera is "armed" when the read out of the acquired frame is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or frame read out*.

When the camera is in External Trigger Mode, the MODE LED will be illuminated on the camera back to indicate the camera is expecting a signal on serial bit [0] of the Control Register, or the TRIGGER IN connector.

Because this signal is internally OR'ed with the TRIGGER IN input, care must be taken to ensure the TRIGGER IN signal is not changed from logic 0 to 1 while triggering with bit [0] of the Control Register.

External Integration/SMA Trigger

When in External Integration / SMA mode, a TTL rising edge on the **TRIGGER IN** signal triggers the camera to acquire one frame of data. Integration begins within 175 ns after the rising edge and stops within 200 ns after the falling edge. After that single frame acquisition, the camera outputs the just acquired frame and "re-arms", thus waiting for a

new External Trigger signal to trigger a new frame acquisition. The camera is "armed" when the read out of the acquired frame is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or frame read out*. This means in this mode TRIGGER IN necessarily controls both integration and frame rate.

When the camera is in External Integration Mode, the MODE LED will be illuminated on the camera back to indicate the camera is expecting a signal on the TRIGGER IN connector or Serial Trigger bit [0] of the Control Register.

Because this signal is internally OR'ed with the Serial Trigger bit [0] of the Control Register, care must be taken to ensure the bit [0] of the Control Register is not changed from logic 0 to 1 while triggering with the TRIGGER IN connector.

External Integration/Serial Trigger

When in External Integration / Serial mode, a TTL rising edge on bit [0] of the Control Register triggers the camera to acquire one frame of data. Due to variation in the host operating system, this mode is generally used only for camera setup and functional testing. Integration begins within 175 ns after the rising edge and stops within 200 ns after the falling edge. After that single frame acquisition, the camera outputs the just acquired frame and "re-arms", thus waiting for a new External Trigger signal to trigger a new frame acquisition. The camera is "armed" when the read out of the acquired frame is completed. *No additional rising edges, or triggers, should be allowed during the image acquisition or frame read out*. This means in this mode TRIGGER IN necessarily controls both integration and frame rate.

When the camera is in External Integration Mode, the MODE LED will be illuminated on the camera back to indicate the camera is expecting a signal on serial bit [0] of the Control Register, or the TRIGGER IN connector.

Because this signal is internally OR'ed with the TRIGGER IN input, care must be taken to ensure the TRIGGER IN signal is not changed from logic 0 to 1 while triggering with bit [0] of the Control Register.

3.15 Controlling Frame Rate

The 4M30 allows you to control frame rate in three ways:

- **Free Running (Programmed Integration time):** The camera free runs with the internally programmed integration time which can be used to set frame rate.
- **External Trigger/Internal Integration:** The camera frame rate will be controlled by the TTL pulse on the TRIGGER IN SMA connector or serial bit [0] of the Control Register. The camera will integrate for the programmed integration time. For more information, refer to section 3.14 Controlling Integration Mode.
- **External Integration:** The camera frame rate will be controlled by the TTL pulse on the TRIGGER IN SMA connector or serial bit [0] of the Control Register. The camera will integrate for as long as the pulse is held high. In this mode, TRIGGER IN also controls integration. For more information, refer to section 3.14 Controlling Integration Mode.

Free Running

Frame Rate can only be controlled by setting integration time.

To specify programmed frame rate (by using integration time):

1. Set bit [7] of the Control Register to 0 (Integrate Mode = Internal), and bit [3] of the Control Register to 0 (Trigger Mode = Internal). To determine the integration time needed for a specific frame rate use the following equation:

   Integration Time = (1/Frame rate) - 32.35ms

2. Write the 3-byte Integration value (in µs) to the three Integration registers. These three bytes are then combined to form a 24 bit frame Integration time. The number programmed in the three registers should not be below 10 µS (0000Ah), or above the calculated value noted in section 3.13 Triggering, Integration, and Frame Rate Overview.
3. Using the command 82h, set bit [7] of the data byte to 0 (Integration Mode = Internal) and bit [3] of the data byte to 0 (Trigger Mode = Internal).

   NOTE: All bits within the register are written at one time. Ensure the correct value for all bits are used when changing camera modes.

4. Use commands 8Ah, 8Bh, 8Ch to set the 24-bit Integration time value.

   Value = 1/25s –32.35ms

   = 4650 μs

   = 00122Ah

	Write Frame Rate LS Byte		Write Frame Rate Center Byte		Write Frame Rate MS Byte	
	Command	Value	Command	Value	Command	Value
Binary	1000 1010	0010 1010	1000 1011	0001 0010	1000 1100	0000 0000
Hex	8Ah	2Ah	8Bh	12h	8Ch	00h

External Trigger/Programmed Integration

This is the same as Programmed Integration / SMA Trigger Mode or Programmed Integration / Serial Trigger Mode. Reference to section 3.14 Controlling Integration Mode.

Example: Set the Frame Rate to 2.5 fps

1. Refer to section 3.13 Triggering, Integration, and Frame Rate Overview to ensure that the desired frame rate can be supported for the selected binning and integration modes.
2. Using the command 81h, set bit [0] of the data byte to 0 (Integration Mode = Internal) and bit [3] of the data byte to 1 (Trigger Mode = External).

   NOTE: All bits within the register are written at one time. Ensure the correct value for all bits are used when changing camera modes.

3. Set the desired integration time per section 3.14 – Controlling Integration.

4. Each TTL rising edge on the SMA connector or serial bit [0] of the Control Register will initiate a new frame of data, using the programmed integration time. To achieve 2.5 fps, a TTL pulse must be sent to the camera every 400 ms (1 / 2.5).

External Integration

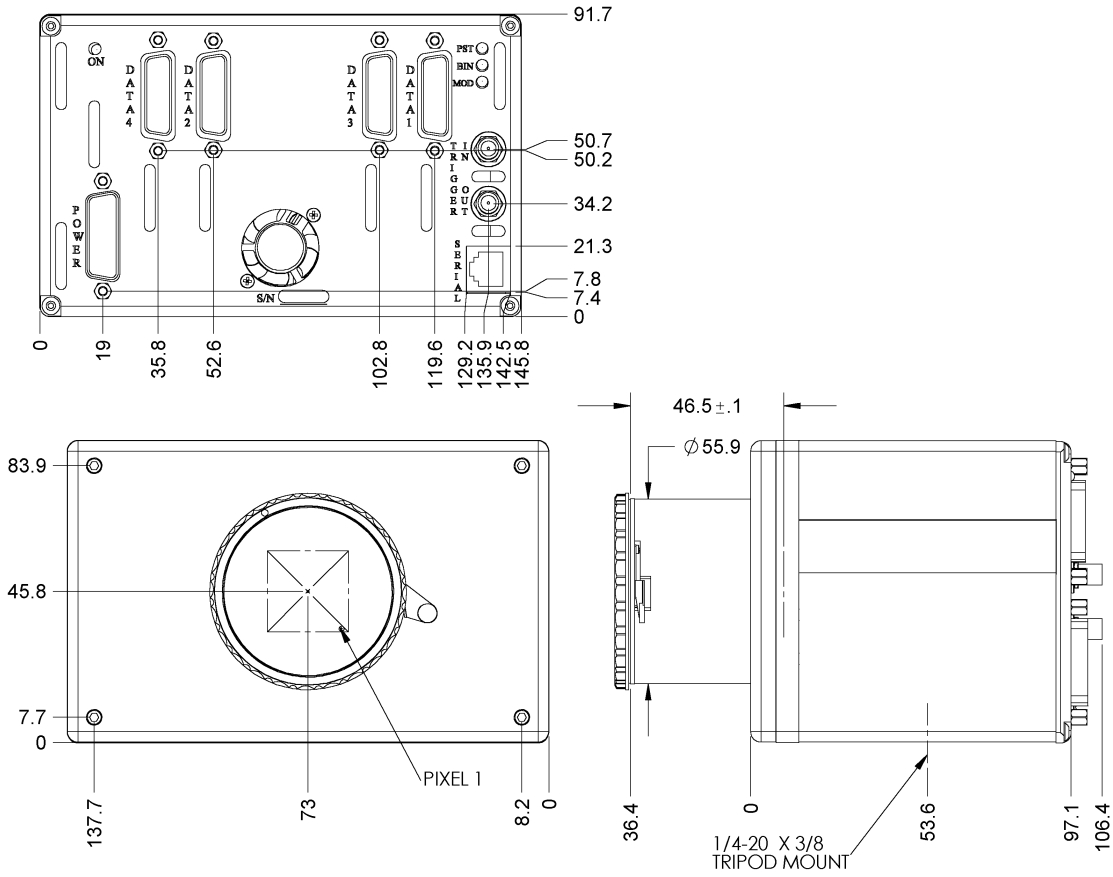
This is the same as the External Integration / SMA Trigger Mode or the External Integration / Serial Trigger Mode. Refer to section 3.14 Controlling Integration Mode.

4

Optical and Mechanical Considerations

4.1 Mechanical Interface

Figure 8: Camera Dimensions



4.2 Mechanical Tolerances

Not applicable to part number DS-46-04M30

Table 18: Mechanical Tolerances

Additional Dimensions	
Center of sensor with respect to lens mount	<.025”
Planarity of lens flange to sensor	<.010"
Rotation of sensor	<.3°

4.3 Mounting the Camera

The 4M30 can be mounted via the 3/8” deep, 1/4”-20 threaded tripod mount located on the bottom of the camera.

5

Cleaning and Maintenance

5.1 Cleaning

This section is not applicable to part number DS-46-04M30

Electrostatic Discharge and the CCD Sensor

Charge-coupled device (CCD) image sensors are metal oxide semiconductor (MOS) devices and are susceptible to damage from electrostatic discharge (ESD). Although many sensor pins have ESD protection circuitry, the ESD protection circuitry in CCDs is typically not as effective as those found in standard CMOS circuits.

Electrostatic charge introduced to the sensor window surface can induce charge buildup on the underside of the window that cannot be readily dissipated by the dry nitrogen gas in the sensor package cavity. When charge buildup occurs, surface gated photodiodes (SGPDs) may exhibit higher image lag. Some SGPD sensors may also exhibit a highly non-uniform response when affected by charge build-up, with some pixels displaying a much higher response when the sensor is exposed to uniform illumination. The charge normally dissipates within 24 hours and the sensor returns to normal operation.

Preventing ESD Damage

To prevent ESD damage, DALSA advises you to take the following handling precautions.

1. Ground yourself prior to handling CCDs.
2. Ensure that your ground and your workbench are also properly grounded. Install conductive mats if your ground or workbench is non-conductive.
3. Use bare hands or non-chargeable cotton gloves to handle CCDs. NOTE: Rubber fingercots can introduce electrostatic charge if the rubber comes in contact with the sensor window.
4. Handle the CCD from the edge of the ceramic package and avoid touching the sensor pins.
5. Do not touch the window, especially in the region over the imaging area.

6. Ground all tools and mechanical components that come in contact with the CCD.
7. DALSA recommends that CCDs be handled under ionized air to prevent static charge buildup.
8. Always store the devises in conductive foam. Alternatively, clamps can be used to short all the CCD pins together before storing.

The above ESD precautions need to be followed at all times, even when there is no evidence of CCD damage. The rate which electrostatic charge dissipates depends on numerous environmental conditions and an improper handling procedure that does not appear to be damaging the CCDs immediately may cause damage with a change in environmental conditions.

Protecting Against Dust, Oil, and Scratches

The CCD window is part of the optical path and should be handled like other optical components, with extreme care.

Dust can obscure pixels, producing dark patches on the sensor response. Dust is most visible when the illumination is collimated. The dark patches shift position as the angle of illumination changes. Dust is normally not visible when the sensor is positioned at the exit port of an integrating sphere, where the illumination is diffuse.

Dust can normally be removed by blowing the window surface using clean, dry, compressed air, unless the dust particles are being held by an electrostatic charge, in which case either an ionized blower or wet cleaning is necessary.

Oil is usually introduced during handling. Touching the surface of the window barehanded will leave oily residues. Using rubber fingercots and rubber gloves can prevent contamination. However, the friction between rubber and the window may produce electrostatic charge that may damage the sensor. To avoid ESD damage and to avoid introducing oily residues, only hold the sensor from the edges of the ceramic package and avoid touching the sensor pins and the window.

Improper handling, cleaning or storage of the sensor can cause scratches. Vacuum picking tools should not come in contact with the window surface. CCDs should not be stored in containers where they are not properly secured and can slide against the container.

Scratches diffract incident illumination. When exposed to uniform illumination, a sensor with a scratched window will normally have brighter pixels adjacent to darker pixels. The location of these pixels will change with the angle of illumination.

Cleaning the Sensor Window

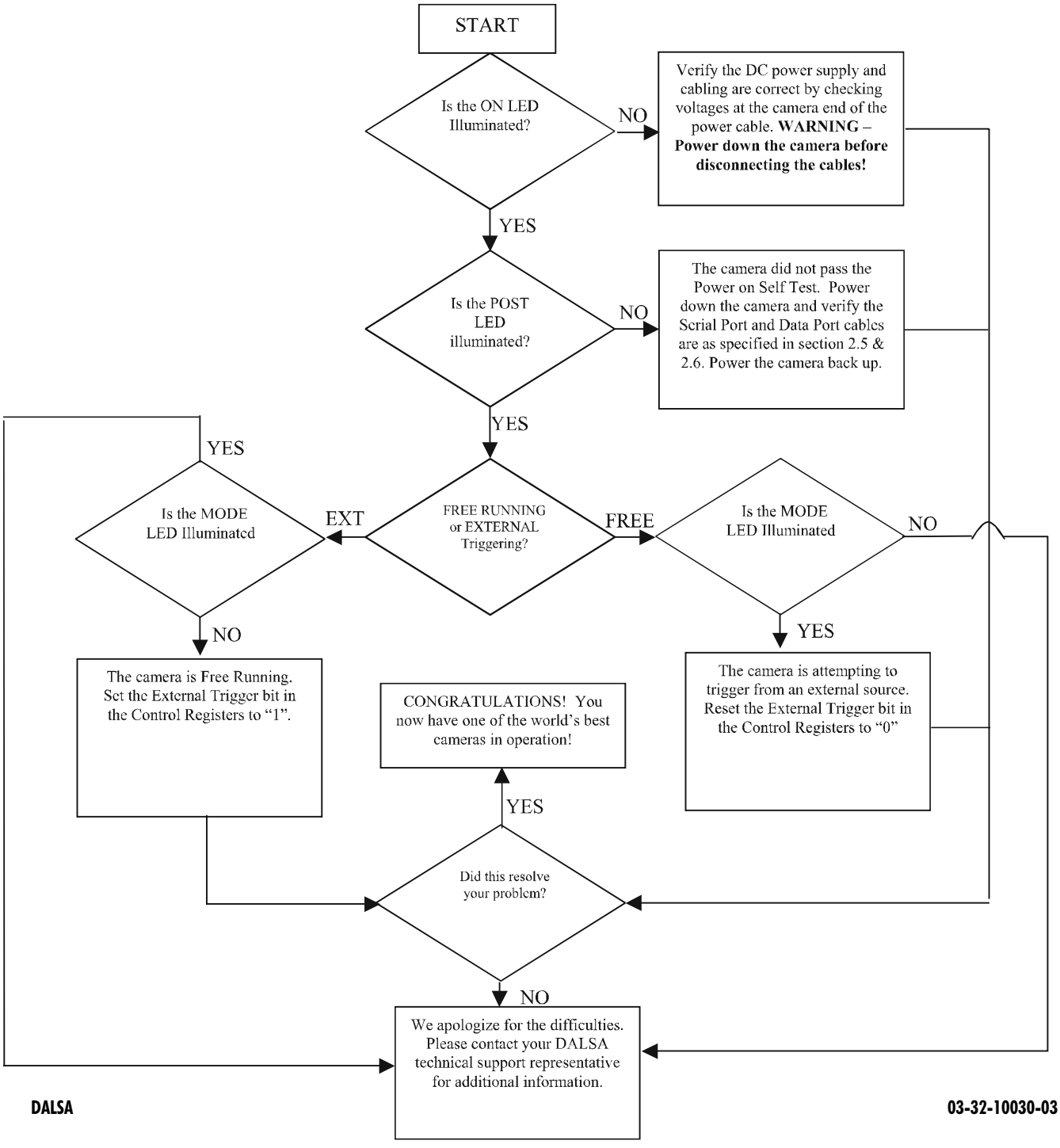
1. Use clean, dry, compressed air to blow off loose particles. This step alone is usually sufficient to clean the sensor window.
2. If further cleaning is required, use a lens wiper moistened with alcohol.
3. We recommend using lint free, ESD safe cloth wipers that do not contain particles that can scratch the window.
4. Wipe the window carefully and slowly.

5.2 Maintenance

There are no user serviceable parts on this camera. Please contact DALSA service.

6

Troubleshooting


START
Is the ON LED Illuminated?
NO
Verify the DC power supply and cabling are correct by checking voltages at the camera end of the power cable. WARNING – Power down the camera before disconnecting the cables!
YES
Is the POST LED illuminated?
NO
The camera did not pass the Power on Self Test. Power down the camera and verify the Serial Port and Data Port cables are as specified in section 2.5 & 2.6. Power the camera back up.
YES
FREE RUNNING or EXTERNAL Triggering?
EXT
Is the MODE LED Illuminated
YES
NO
The camera is Free Running. Set the External Trigger bit in the Control Registers to "1".
FREE
Is the MODE LED Illuminated
NO
YES
The camera is attempting to trigger from an external source. Reset the External Trigger bit in the Control Registers to "0"
CONGRATULATIONS! You now have one of the world's best cameras in operation!
YES
Did this resolve your problem?
NO
We apologize for the difficulties. Please contact your DALSA technical support representative for additional information.

7

Warranty

7.1 Limited One-Year Warranty

What We Do

This product is warranted by DALSA for one year from date of original purchase. Please refer to your Purchase Order Confirmation for details.

What is Not Covered

This warranty does not apply if the product has been damaged by accident or misuse, or as a result of service or modification by other than DALSA, or by hardware, software, interfacing or peripherals not provided by DALSA. DALSA shall have no obligation to modify or update products once manufactured. This warranty does not apply to DALSA Software Products.

Note: If the camera has a non-standard cover glass (part number DS-46-04M30) the warranty is void on the CCD.

How to Obtain Service for Your Equipment

If you want to return your product for repair, contact DALSA Customer Service in order to obtain a Return Goods Authorization form. Repair cannot begin until the form is issued, completed, and returned to DALSA

DALSA Technical Support

Phone: 519 886 6000
Fax: 519 886 8023
email: support@DALSA.com

Appendix A

LVDS (EIA-644) Reference

EIA-644 is an electrical specification for the transmission of digital data. The standard is available from the EIA (Electronic Industries Association). It defines voltage levels, expected transmission speeds over various cable lengths, common mode voltage operating requirements for transmitters and receivers, and input impedances and sensitivities for receivers.

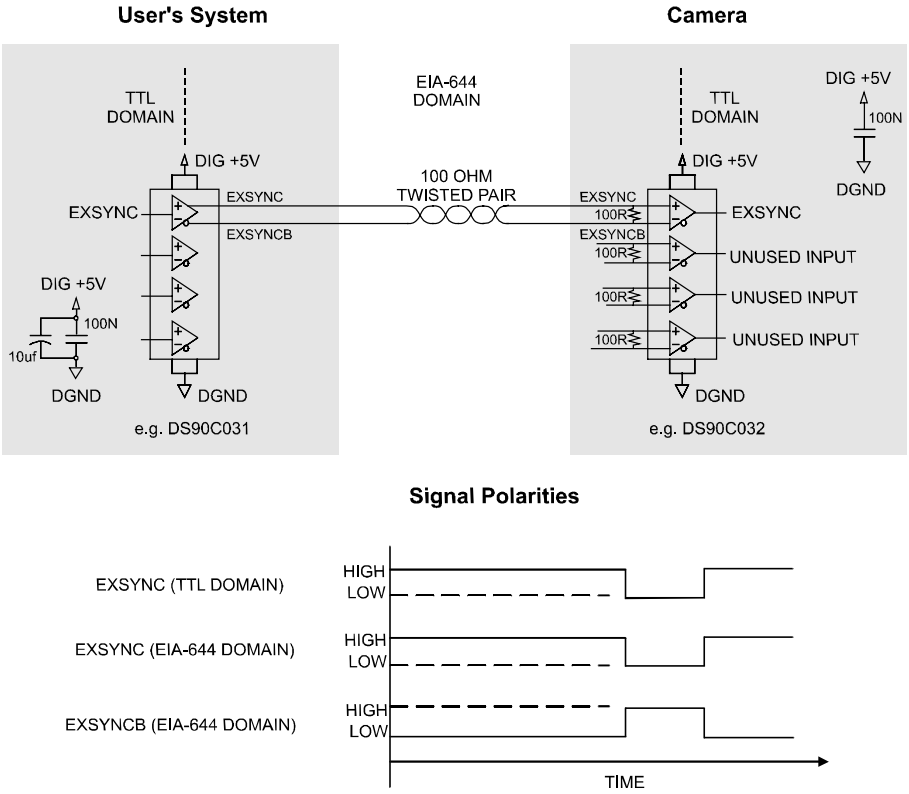
The standard requires that two wires (e.g. twisted pair) be used to transmit one signal in a differential mode. This means that one wire will be logic HIGH while the other wire is logic LOW. Voltage swing between HIGH and LOW is approximately 350mV, with a typical offset of approximately 1.25V. The use of differential signal transmission allows the receiver to reject common mode voltages. This noise rejection improves data integrity and allows cameras to be installed in an industrial environment.

EIA-644-compatible line receivers and drivers are available from many different IC manufacturers in a variety of fabrication technologies such as CMOS and GaAs. The EIA-644 standard does not define specific voltages, so it can migrate from 5V power supplies to 3.3V and sub-3V. DALSA recommends the use of 5V CMOS line drivers and receivers such as National Semiconductor parts DS90C0C31 quad line driver and DS90C032 quad line receiver.

To achieve full benefit of the common mode rejection, twisted pair cable should be used for all EIA-644 signals. The cable impedance should be 100 Ohms and the cable terminated at the receiving end with a 100 Ohm resistor. All EIA-644 inputs in a DALSA camera are terminated with 100 Ohms between the (+) and (-) of a signal. Figure A-1 (a) shows an example of an EIA-644 transmission.

DALSA indicates the (+) signal by the name of the signal; i.e. MCLK, while the (-) signal is indicated by either an overscore over the name or appending the letter B to the end of the name; i.e. $\overline{\text{MCLK}}$ or MCLKB. The (+) signal has the same sense as the TTL signal which is sent or received; i.e. when MCLK in the TTL domain is HIGH then MCLK in the EIA-644 domain is HIGH. The (-) signal has the opposite sense of the TTL domain signal and so if MCLK TTL is HIGH then MCLKB EIA-644 is LOW. Figure 9 shows the relationship.

Figure 9. EIA-644 Example



Unused EIA-644 Inputs and Outputs

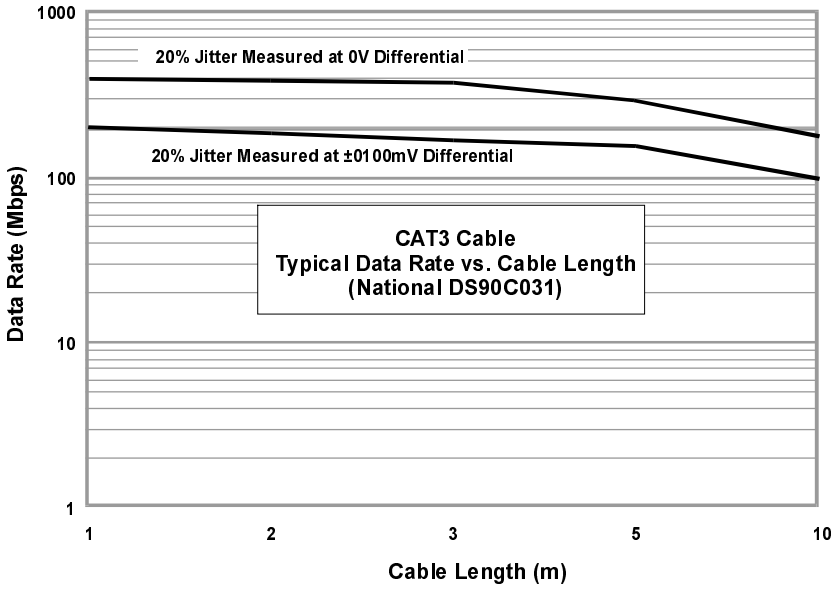
Unused **outputs** should be left unconnected. This will reduce power dissipation within the camera and reduce radiated emissions.

Unused **inputs** should also be left unconnected; EIA-644 chips have fail-safe features that guarantee a known logic state (HIGH) in fault conditions (unconnected, shorted, or unterminated). **Do not connect cables to unused inputs.** Cables can act as antennae and cause erratic camera behavior.

Cable Lengths

Figure 10 shows a graph of ideal communication data rate vs. cable length for the EIA-644 standard.

Figure 10. EIA-644 Data Rate vs. Cable Length



Index

A

About DALSA, 2
ADC
  board, 22
  definitions, 19
aperture, 7
applications, 5
automatic offset (AOC), 25

B

baud, 15
BIN LED, 10

C

cables
  Digi-Key, 15
  length, 40
calibration conditions, 8
camera dimensions, 32
CCD, 6
clocking signals, 13
commands
  ADC, 18, 20
  clock, 18, 20
  protocol, 18
  read, 19
  write, 19
connectors, 11, 12, 13, 15
  data output, 9
  power, 11
  SMA, 15
control register, 21

D

data
  bits, 15
  clocking signals, 13
  format, 7
  output, 12
  output connector, 9
  rate, 7
  read out, 12
definitions
  ADC, 19
  data clocking, 13
  data signal, 13
  timing, 17
DTE, 14
dynamic range, 8

E

EIA-644, 39
  inputs/outputs, 39
ESD damage, 34
External Integrate Mode, 28

F

features, 5
firmware revision, 22
frame rate, 29
frame transfer, 6

G

gain, 8
  adjusting, 23
  equation, 23
  range, 8

H

hard reset, 22
HSYNC, 13

I

inputs/outputs, 10, 40
installation, 9
integration
  external, 31
  mode, 26
  time, 26
  time, equation, 26, 30

L

LED, 10
lens
  flange, 33
  mount, 33
logic HIGH and LOW, 39
LVDS, 9, 12, 13, 39
  inputs/putputs, 40

M

mass, 7
mechanical interface, 32
mode
  free running, 27
  integration, 26
  LED, 10
  No Clean, 26
  trigger, 27
MODE LED, 10

N

noise, 8

O

offset
  automatic (AOC), 25
  user, 24
ON LED, 10
operating ranges, 7
operating temp, 7

P

parity, 15
performance specifications, 7
physical characteristics, 7
pinout, 11, 12, 13
PIXCLK, 13
pixel size, 7
POST LED, 10
power dissipation, 7
power supply, 11
PRNU, 8

R

register
  bit definitions, 21
resetting, 22
resolution, 7
RJ-11, 14
RMS noise, 8
RS-232, 13, 18
RS232 serial port, 9

S

sensor, 6
  block diagram, 6
  characteristics, 6
  cleaning, 35
  protection, 35
  rotation, 33
  structure, 6
serial communication, 13
serial trigger, 28
signals
  data, 13
size, 7
SMA
  connector, 13, 15
  trigger, 28
soft reset, 22
specifications, 7
  electro-optical, 8
start bit, 15
state diagrams, 17
stop bit, 15

T

Technical Support, 38
telephone-style connector, 14
temperature, 7
timing
  camera, 16
  HSYNC, 17
  integration, 16, 26
  integration, equation, 30
  shutter, 16
  trigger, 16
  VSYNC, 17
timing diagrams, 17
trigger
  external, 30
  modes, 27
  serial, 29
  SMA, 28
  timing, 16
triggering, 26, 30
TTL Trigger, 15

U

user offset, 24

V

VSYNC, 13

W

warranty, 38